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THESIS

Analysis of Marine Corps Small Arms Proficiency with Emphasis on Requalifications.

by

Charles Edward Walters

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The purpose of the study was to determine to what extent that an individual's marksmanship performance is degraded after a one, two, three, or four plus year gap in his small arms weapon requalification history. The study reviews the physiological aspects of proficient shooting and the effects of the environment on marksmanship shooting. The analysis was performed on the complete qualification history of 1,694 U. S. Marine Corps officer and enlisted personnel who had qualified with a pistol or rifle three or more times during

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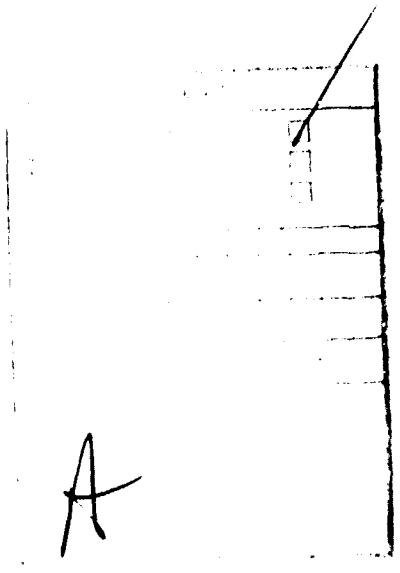

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Analysis of Marine Corps Small Arms Proficiency with Emphasis on Requalifications

by

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Submitted in partial fullfillment of the requirements for the degree of

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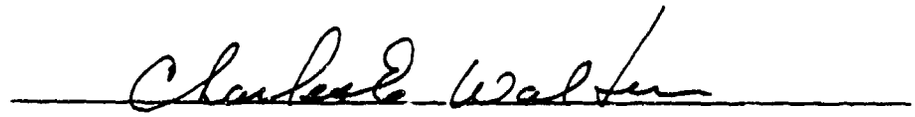
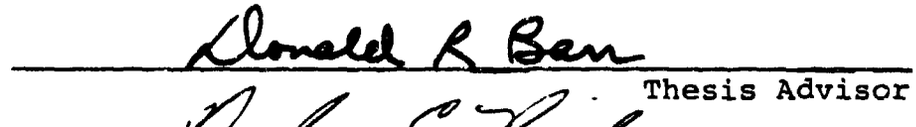
Author 

Approved by: 
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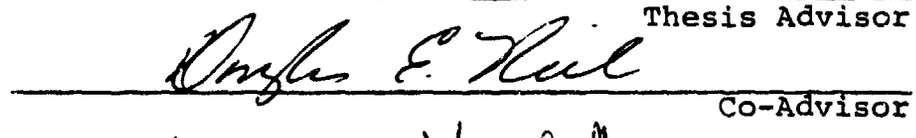
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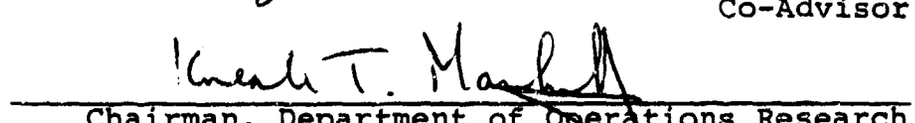
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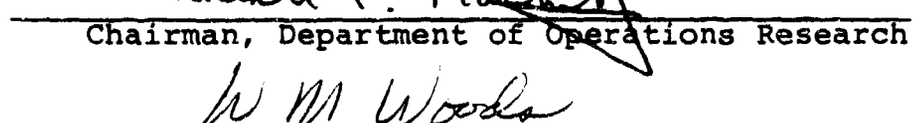
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ABSTRACT

The purpose of the study was to determine to what extent that an individual's marksmanship performance is degraded after a one, two, three, or four plus year gap in his small arms weapon requalification history. The study reviews the physiological aspects of proficient shooting and the effects of the environment on marksmanship shooting. The analysis was performed on the complete qualification history of 1,694 U. S. Marine Corps officer and enlisted personnel who had qualified with a pistol or rifle three or more times during their Marine Corps career. The results of the analysis indicated that there was no statistical degradation in shooting performance for both the officer and enlisted populations over gaps of one or more years when firing the rifle. In the case of the pistol, there was no statistical degradation in performance for the officer population with a gap of one or more years in shooting history; however, the enlisted population shows statistical evidence of degradation in performance after a three or more year gap in shooting history.

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I. INTRODUCTION

A. PURPOSE

The purpose of this study is to determine to what extent an individual's marksmanship performance is degraded after a break in his small arms weapon requalification history. This study tests the null hypothesis that marksmanship performance is not degraded after a break in small arms weapon requalification against the alternative hypothesis that marksmanship performance is degraded following a break in small arms weapon requalification training.

The study reviews the physiological aspects of proficient marksmanship shooting which involves the human motor appartus, the visual system, the breathing process and the environment in which the marksman is performing his skills. The study analyzes the complete qualification history of U. S. Marine Corps officers and enlisted personnel who had qualifed with a rifle or pistol for requalification three or more times during their Marine Corps career. A review of Marine Corps policy and procedures regarding marksmanship training is presented so that the reader will have an understanding of how the data base utilized in the study was generated.

The data analysis portion of the study analyzes a break or gap of one, two, three, or four plus years in the requalification cycle of an individual Marine and its effect on his marksmanship performance. A regression analysis was performed

in terms of time and gains or drops in score across gaps in shooting histories. This provides a method of testing the significance of changes in score over time.

B. PHYSIOLOGICAL CONSIDERATIONS

> "The Marine rifleman of the next conflict will be, as he has been in the past, among the first to confront the enemy and the last to hang his weapon in the rack after the war is won." [Ref. 1]

The above quotation illustrates the importance of marksmanship training for the individual Marine, whether he is an officer or enlisted, infantryman or jet mechanic. Each Marine is trained as a Marine rifleman with emphasis on marksmanship proficiency to the extent that he would be capable of effectively applying learned shooting skills in a combat environment [Ref. 1]. In the process of developing individual small arms proficiency, numerous physiological aspects of the human body must be considered. The physiological aspects of proficient marksmanship shooting involve the human motor apparatus, the visual system, the breathing process, and to some extent, the environment in which the marksman is performing his skills.

1. Human Motor Apparatus

A study performed by A. A. Yur'yev [Ref. 2] analyzed the human motor apparatus subdivided into the system of muscles and the system of bones and ligaments and their interaction when attaining an optimum shooting position. He analyzed the prone, kneeling, and standing positions in detail and determined that the most stable shooting position is the prone, since the body of the rifleman has a low center of gravity

position. The least stable position was the standing position due to the difficulty of attaining complete equilibrium between the body and the weapon. This is largely due to the fact that the weapons center of gravity is located at a distance away from the central line of the rifleman's body requiring a compensating deviation of the torso to create a counterbalance to the rifle. The kneeling position is more stable than the standing position due to the lower center of gravity and greater weight distribution.

2. Visual System

A. A. Yur'yev's [Ref. 2] study also involved an analysis of the visual system which is required to attain proper sight alignment and sight picture during the process of aiming the weapon. The study included the effects of nearsightedness, farsightedness and spherical aberration as they affect shooting performance. His analysis determined that nearsightedness was easily corrected with glasses enabling the shooter to maintain good shooting scores whereas farsightedness was determined to be hard to correct with proper shooting scores. In his discussions of spherical aberration, he identified the need to ensure that the aiming devices do not shine brightly producing a blinding effect on the eye. This difficulty is easily solved by blackening the sights.

In the process of aiming, it is necessary to prevent eye fatigue which can be induced by prolonged aiming. After 12 to 16 seconds, Yur'yev indicates that the eye ceases to

notice inaccuracies in the aiming factors of sight alignment and sight picture. Yur'yev further recommends that the aiming process should not exceed 6 to 8 seconds. In order to rest the eyes, he found that it was helpful to look at distant dull surfaces which exhibit even tones of gray, green, or blue.

3. Breathing Process

A. A. Yur'yev [Ref. 2] analyzes the critical aspects of breathing rhythm on marksmanship firing. He deduced from his study that an individual can hold his breath for 12 to 15 seconds without special labor. Longer periods result in higher level of carbon dioxide in the blood resulting in muscle reactions which can have an effect on the steadiness of the weapon. This is due in large part to the fact that the process of breathing consists of a combination of physiological processes which constantly occur in an organism and are linked with blood circulation, gas exchange, metabolism and the nervous system of the organism. The proper control of breathing is necessary to prevent unnecessary movement of the weapon during the aiming and firing process.

4. Coordination of Aiming, Breathing, and Trigger Squeeze

Prior to firing the weapon at a target, it is desirable that the shooter consider the coordination of aiming, breathing and trigger squeeze during the weapon firing sequence. A. A. Yur'yev's [Ref. 2] study identified the technique of trigger pull as being "of very great importance in producing an accurate

shot." The coordination of aiming, breathing and simultaneously squeezing the trigger is of great importance during the process of firing a weapon. During the trigger squeeze evolution, the shooter must maintain a steady aim and to do so, he must also control his breathing. If his breathing is not controlled, the weapon may move, resulting in the point of aim not being on target, and an inaccurate shot being fired. In order to maintain proper coordination, Yur'yev suggests that the trigger be smoothly pulled straight back with a maximum time for trigger squeeze to be 2 to 2.5 seconds.

5. Weapon Steadiness as Related to Experience

A study performed by Rigby [Ref. 3] tested the hypothesis that a group of shooters which had had rifle training with improved levels of skills at rifle marksmanship should perform better on a test of rifle steadiness than a similar group which did not have any rifle training. The results of the test showed that rifle training did not improve rifle steadiness. His study also supported the idea that shooting high scores requires being an expert at pulling the trigger at the proper time when sights are properly aligned with the target. He also points out that most models used to predict performance for individual competitions did not accurately predict because they could not account for physiological and situational variables of competition.

6. Environmental Influences

A study performed by Lunsford [Ref. 4] demonstrated that there are certain statistical aspects of weapon training and temperature which lead to a conclusion that climatic conditions can have an appreciable effect on the qualification scores of marksmanship training. He noted that with a humidity factor of 30 to 70%, the following effects of temperature may be evident:

85°F - Mental deterioration begins

75°F - Physical deterioration begins

65°F - Optimum conditions for physical activity

50°F - Physical stiffness of hands begin

The Fleet Marine Force Manual, FMFM 1-3 [Ref. 1] indicates that wind, illumination, temperature and humidity all have some effect on the shooter. The manual further notes that the effect of wind is the greatest problem to the shooter, particularly in the standing position where the stronger the wind, the greater the difficulty of holding the weapon steady. The effects of the wind, depending on its direction, also have a pronounced effect on the projectile as it travels down range. A tail wind or head wind has very little effect on the projectile, but a cross wind does have a significant effect. Wind can be compensated for by adjustment of sight alignment. The military rifle is equipped with adjustable sights which can be adjusted for the effects of wind, thereby reducing the inaccuracies of firing a rifle in a cross wind.

C. MARINE CORPS MARKSMANSHIP TRAINING

1. Marine Corps Small Arms Marksmanship Training Objectives

Marine Corps Order 3574.2F provides that the objective of marksmanship training is to develop marksmanship proficiency to the highest practicable level in individuals and tactical units. The purpose of annual small arms requalification training is to maintain or refine marksmanship proficiency with a minimum performance objective of at least a Marksman classification [Ref. 5].

2. Weapon Types

The Marine Corps currently utilized the M1911A1 .45 caliber pistol, the Smith and Wesson Model 10 .38 caliber revolver and the M16A1 service rifle which fires a 5.56mm round.

3. Marine Corps Marksmanship Program

Marine Corps Order 3574.2F [Ref. 5] establishes Marine Corps policy and prescribes required actions concerning marksmanship training with individual small arms.

a. Marine Corps Policy

Marine Corps policy requires that every Marine be thoroughly trained and capable of using, safely and effectively, those individual small arms weapons appropriate to the Marines' rank and duty assignment. Male Marine officers fire for initial qualification with both the rifle and pistol, whereas the male enlisted Marine fires the M16A1 service rifle for initial qualification during recruit training. Thereafter, those skills

which were attained during initial marksmanship training are supposed to be maintained or improved through annual requalification firing. Women Marines are provided marksmanship training and fire for requalification only when armed in the performance of their assigned duties [Ref. 5].

b. Requalification Requirements

Marine Corps requalification requirements are broken down into two categories, Regular ground organizations and Regular aviation organizations. Each organization has specific requirements which must be met in the annual requalification cycle.

(1) Marines Assigned to Regular Ground Units. Marines assigned to Regular ground organizations are required to fire the M16A1 service rifle for requalification on the known distance (KD) course which is described in Appendix A. The training spans a five day period except for those Marines whose last recorded qualification was Expert, they may choose to fire for record on the third day of training. Appendix A provides for each type of qualification course; the type of range, event times for strings of fire, number of rounds fired per string, the target type utilized, the firing position, and the score/classification breakdown. Those Marines who are armed with the M1911A1 pistol or .38 revolver are required to fire the pistol "A" course for requalification as described in Appendix A. The training spans a five day period with one hour per day involving live fire exercises.

(2) Marines Assigned to Aviation Organizations. Marines assigned to aviation organizations are required to fire the M16A1 service rifle for requalification on the "B Modified" course, as described in Appendix A, which requires three days of live fire training. Male enlisted Marines are required to fire the KD course for requalification every four years. Those Marines armed with the M1911A1 pistol or the .38 caliber revolver are required to fire the pistol "A" course for requalification. The training spans a five day period with one hour per day involving live fire exercises.

4. Record Keeping Requirements

Marine Corps Order 3574.2F [Ref. 5] sets forth strict procedures and guidelines which must be utilized for recording marksmanship record firing results. Once a Marine has declared his intentions to fire for record, that individual is prohibited from receiving any coaching assistance during the record firing events identified for each marksmanship course in Appendix A. Appendix B provides specific procedures and requirements utilized in the determination of a final qualification or requalification score resulting from the record firing events. The final score becomes a permanent record to be recorded in the Officer's Qualification Record (OQR) or the Enlisted Service Record Book (SRB), as appropriate, with the date of qualification, the type of weapon fired, the marksmanship course qualified upon, the score and the qualification classification. Appendix C depicts the type of entries recorded on the NAVMC 118 form utilized for recording marksmanship scores.

D. DIFFERENCES BETWEEN A .45 CALIBER AND .38 CALIBER WEAPON

There have been conflicts of opinion concerning the handling characteristics of the M1911A1 .45 caliber pistol and the Smith and Wesson .38 caliber revolver. Featherstone and Scaglione [Ref. 6] discovered in their study that there were no statistical differences in the handling characteristics of the M1911A1 .45 caliber pistol and the Smith and Wesson .38 caliber revolver.

It is to be noted that throughout the past 20 or more years, the Marine Corps has not differientated between the M-1 service rifle, M-14 or M16A1 service rifles in regards to target scores. All three weapons have been fired on the same type ranges without score or qualification modifications. The same is also true for the .45 and .38 caliber weapons.

E. FISCAL ASPECTS OF MARKSMANSHIP TRAINING

The cost of small arms ammunition is continually rising necessitating money saving programs on the part of the Marine Corps. A Navy Times article [Ref. 6] identified that a recent scarity of .45 caliber ammunition within the Marine Corps required the discontinuation of pistol requalification during the 1980 calendar year except for a small number of selected occupational specialties.

II. METHOD

A. DATA ACCUMULATION

The process of data accumulation involved reviewing 5,800 personnel records maintained by subordinate units of the 3rd Marine Aircraft Wing located at Santa Ana, California, and the 1st Marine Division located at Camp Pendleton, California. Personnel records were reviewed in an alphabetical sequence. From the record books reviewed, the following data were recorded for those individuals who had qualified with a particular weapon type three or more times during their career:

Military Occupational Specialty (MOS)

Type of Weapon Fired

Type of Firing Course Qualified Upon

The Year of Qualification in terms of numerical accession from the first year fired

The Qualification Scores

The above elements were recorded on an 80 card column form in the format depicted by Appendix D. Appendix C represents the NAVMC 118 form utilized by the Marine Corps to record individual marksmanship qualification data for each individual Marine and is a permanent part of the personnel record.

B. DISTRIBUTION OF THE DATA

Table I represents the major Marine Corps commands from which the data were extracted and consists of the number

of records reviewed per unit and the number of data sets that were extracted from that unit.

TABLE I. BREAKDOWN OF DATA EXTRACTION

UNIT	NUMBER OF PERSONNEL RECORDS REVIEWED	NUMBER OF DATA SETS EXTRACTED
1ST MARDIV		
7th Marines	1400	340
11th Marines	1550	300
Division Headquarters	250	168
Total	3200	808
3RD MAW		
MAG-11	1600	520
MAG-16	600	245
H&HS, MCAS(H) Santa Ana	400	121
Total	2600	886

Table II shows a breakdown of the extracted data set by major command and by officer and enlisted categories.

TABLE II. BREAKDOWN OF OFFICER AND ENLISTED DATA

MAJOR UNIT	OFFICER	ENLISTED	TOTAL
1ST MARDIV	225	583	808
3RD MAW	213	673	886
Total	438	1256	1694

Table III shows a breakdown of the data by Military Occupational Specialty (MOS).

TABLE III. BREAKDOWN OF DATA BY MILITARY OCCUPATIONAL SPECIALTY (MOS)

MOS		OFFICER DIVISION	OFFICER WING	ENLISTED DIVISION	ENLISTED WING
0100	Administration	10	5	22	25
0200	Interragotor	6	5	10	8
0300	Infantry	74	0	270	30
0400	Logistics	12	2	8	5
0800	Artillary	59	0	112	13
1000	Utilities	4	0	5	12
2000	Ordnance	28	2	91	27
3000	Supply	6	27	51	87
4000	Data Processing	11	2	5	12
5000	Military Police	4	4	6	11
6000	Maintenance	0	36	1	398
7000	Aviation/ Electronics	12	150	2	28
	Totals	226	233	583	656

C. DATA ANALYSIS

1. General

The data analysis consisted of analyzing the score differences (ΔSCORE) across the first gap/break to occur in an individual's shooting history where ΔSCORE = SCORE (IMMEDIATELY AFTER GAP) - SCORE (IMMEDIATELY BEFORE GAP).

For those individuals without a gap in shooting history, the score differences are between the last time that an individual had fired and the first time that he had fired for qualification where ΔSCORE = SCORE (LAST TIME FIRED) - SCORE (FIRST TIME FIRED).

The analysis was performed upon the following seven data groups:

Officer-Division

Officer-Wing

Enlisted-Division

Enlisted-Wing

Officer Combined

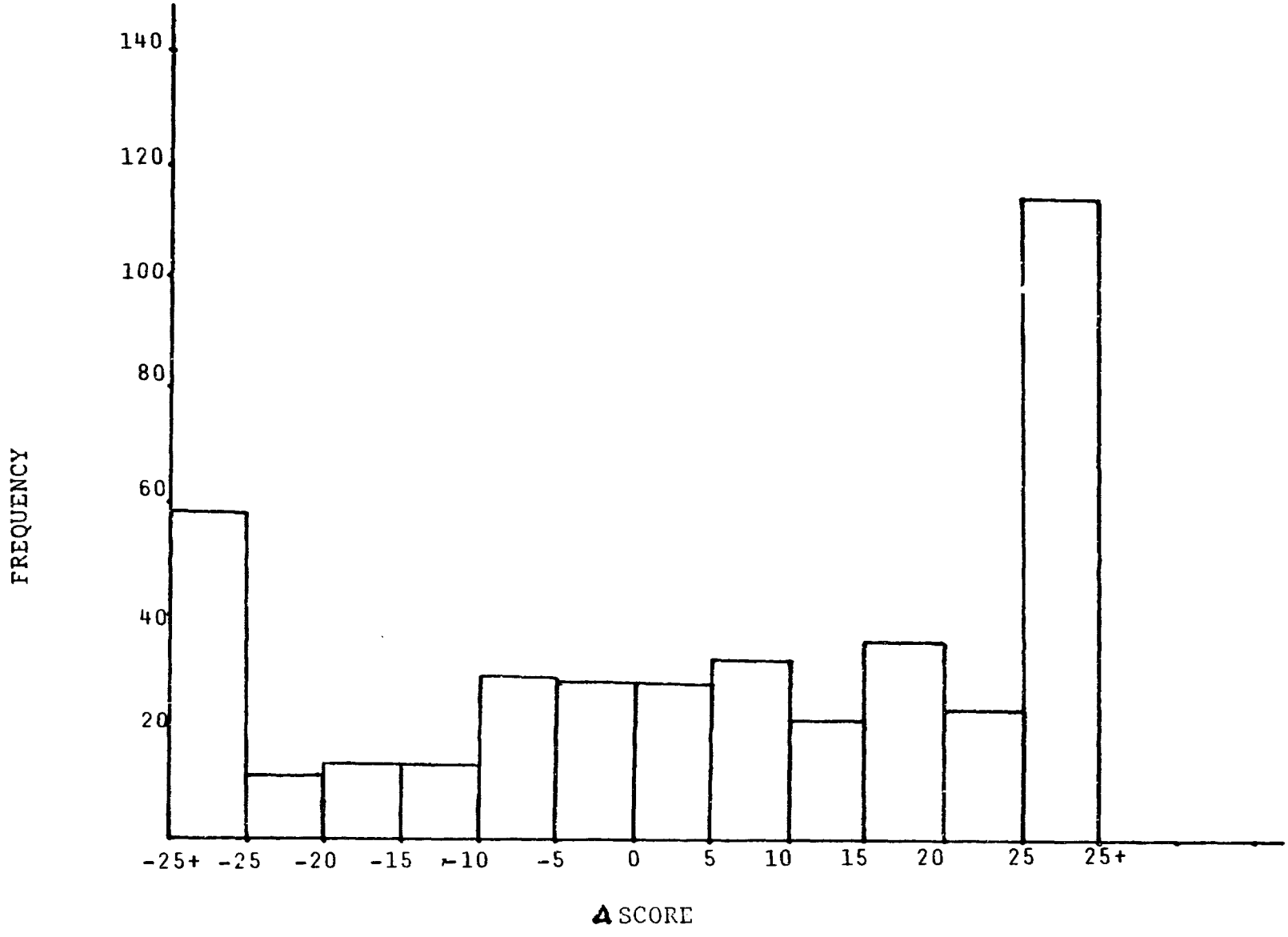
Enlisted Combined

Officer-Enlisted Combined

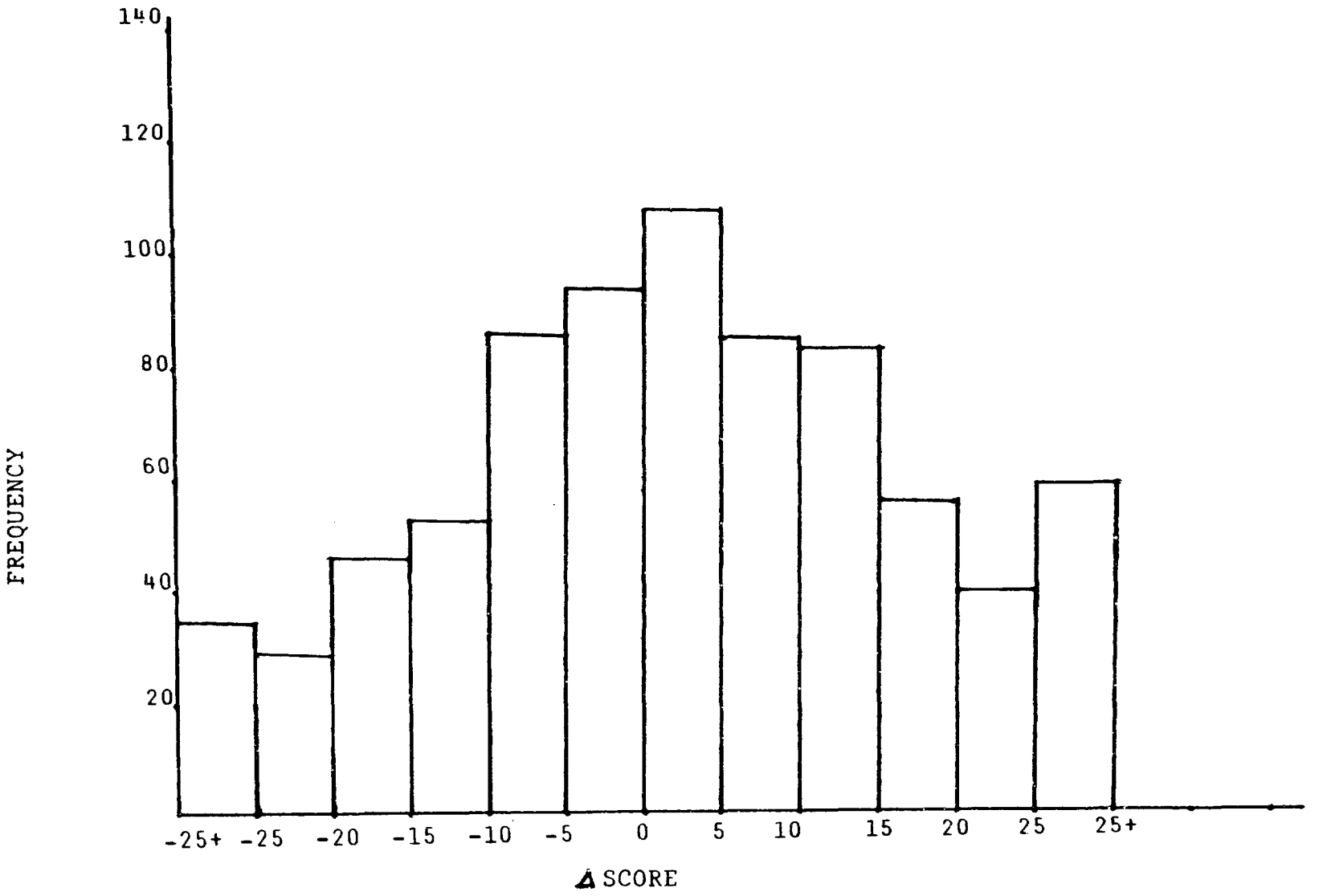
Figures (1) through (4) are histograms of the ΔSCORES for those individuals contained within the Officer-Enlisted Combined data sets.

2. Analysis of Variance

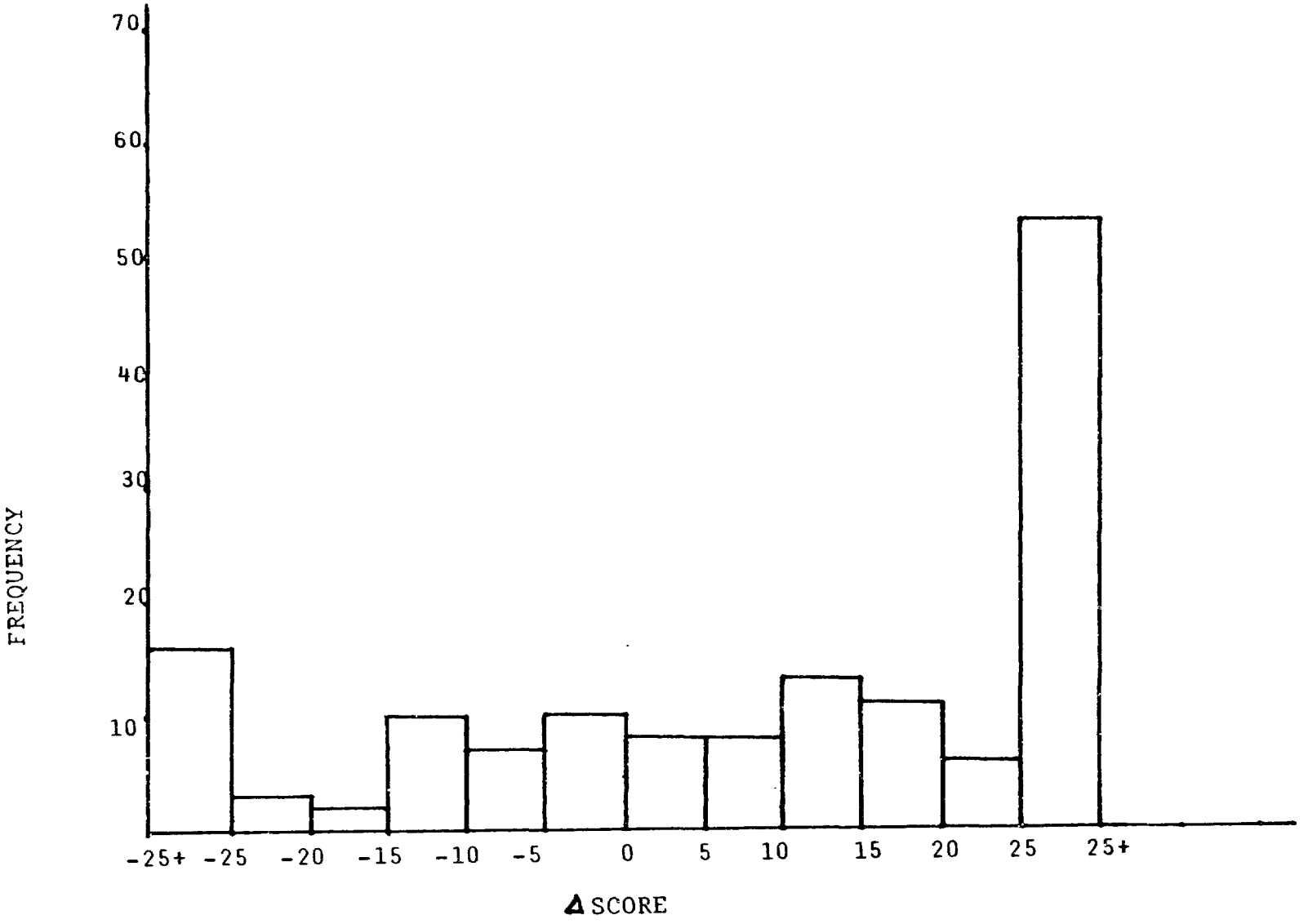
An analysis of variance was performed on the Officer-Division, Officer-Wing, Enlisted-Division, and Enlisted-Wing data groups to determine if there were any significance associated to the treatment groups of individual shooters and time. The Randomized Block Design presented in Hicks [Ref. 8] was utilized to test the hypothesis that there are no treatment effects. The analysis was performed on both



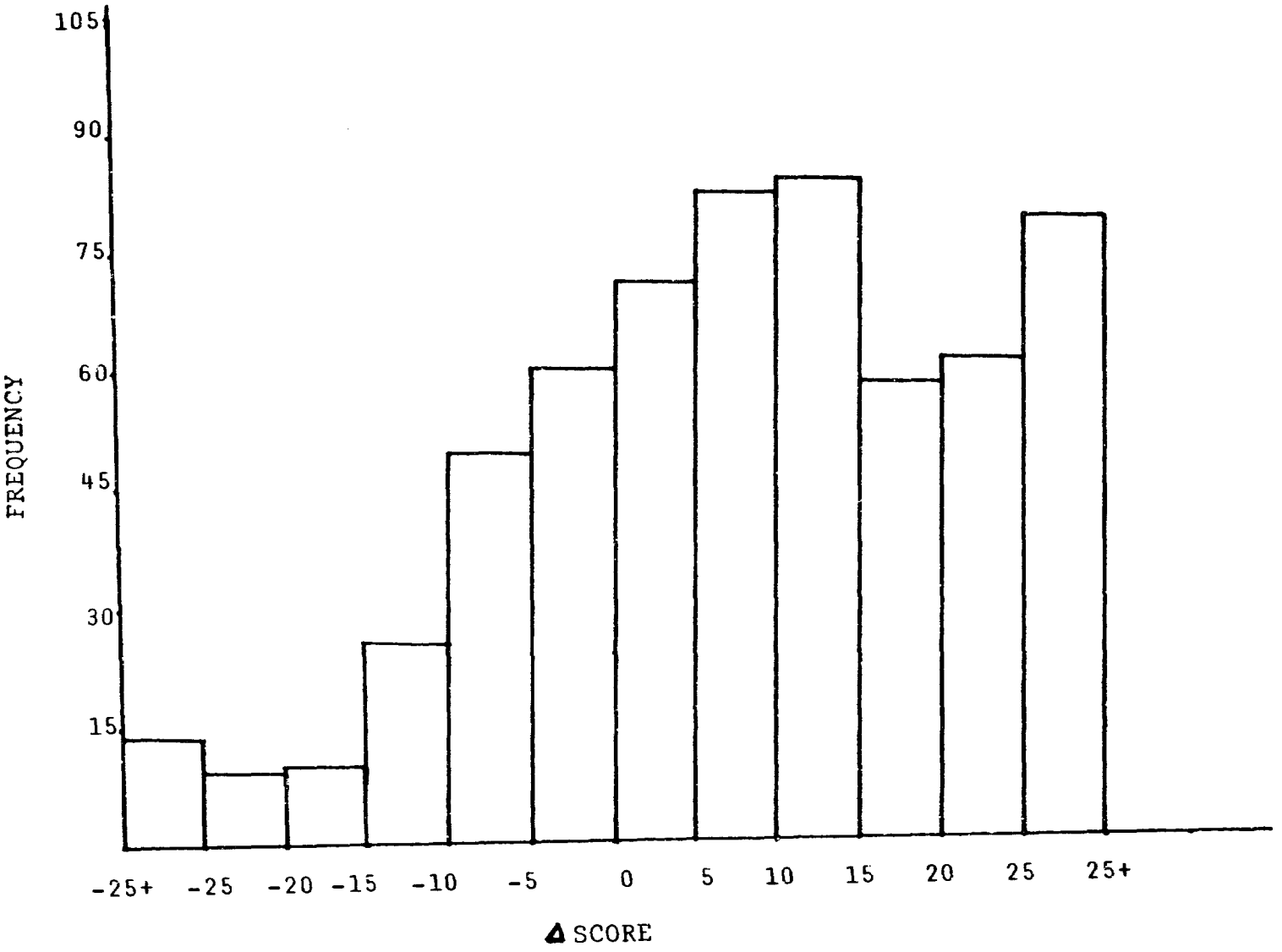
Figure(1) Pistol Δscore for Officer-Enlisted Combined with a Gap



Figure(2) Rifle Δscore for Officer-Enlisted Combined with a Gap



Figure(3) Pistol Δscore for Officer-Enlisted Combined without a Gap



Figure(4) Rifle Δscore for Officer-Enlisted Combined without a Gap

rifle and pistol weapon types. The level of significance (α) used to test the hypothesis was .1.

3. Contingency Table Analysis

A contingency table analysis was performed for both rifle and pistol weapon types to test the hypothesis that there is no statistical difference in ΔSCORES associated with the populations being tested. The level of significance (α) used to test the hypothesis was .1. The ΔSCORES were accumulated into frequency tables for all of the data groups listed in paragraph one. The analysis involved using the Chi-square test as presented in Siegel [Ref. 9] for ΔSCORE versus the below listed data sets for the no gap, the one, two, three, and four plus year gaps in shooting history:

Set 1: Officer-Division, Officer-Wing, Enlisted-Division, Enlisted-Wing

Set 2: Officer-Combined, Enlisted-Combined

Set 3: Officer-Enlisted Combined

In addition, the contingency table analysis was performed on each of the population groups in paragraph one to test the hypothesis that there is no statistical differences in ΔSCOREs for zero, one, two, three, and four plus year gap in shooting history with a significance level (α) of .1.

4. Regression Analysis

A regression analysis was performed on the Officer-Combined, Enlisted-Combined and the Officer-Enlisted Combined data sets for both the pistol and rifle weapon tests by utilizing the APL program provided by Richards [Ref. 10] contained

within the Naval Postgraduate School computer library. The analysis involved regressing ΔSCORE with Time (in years) to test the hypothesis that the ΔSCORES over time, or over a gap in shooting history, have a zero slope. A zero slope would indicate that a shooters' performance over time is not degraded across a specific gap size. The hypothesis was tested at a significance level (α) of .1.

III. RESULTS

A. POPULATION STATISTICS

In the process of analyzing the data, the mean scores and standard deviations for both the pistol and rifle weapon types were calculated and tabulated in Tables IV and V for the following population groups:

Officer-Division

Officer-Wing

Enlisted-Division

Enlisted-Wing

Officer Combined

Enlisted Combined

Officer-Enlisted Combined

Table IV displays the mean scores and standard deviations for all individuals contained within the seven population groups. Since all mean pistol scores are greater than 290 and the mean rifle scores are greater than 210, then from the marksmanship classification breakdown provided in Appendix A, all of the scores listed in Table IV fall into the Marine Corps marksmanship classification of Sharpshooter.

Table V displays the mean scores and standard deviations only for those individuals who had had a gap or break in their requalification history. Again, all of the mean pistol and rifle scores listed fall into the Sharpshooter classification

which is significant since the minimum performance objective is at least a Marksman classification [Ref. 5].

TABLE IV. STATISTICS FOR ALL INDIVIDUALS

DATA SET	NUMBER SUBJECTS PISTOL	NUMBER SUBJECTS RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE
Off-Div	110	114	323.8	222.3	32.4	16.8
Off-Wing	131	101	336.9	219.7	29.6	20.5
Enl-Div	85	497	306.6	212.3	38.3	14.6
Enl-Wing	140	515	313.9	212.2	36.0	14.5
Officer	241	216	331.1	221.1	31.6	18.6
Enlisted	226	1012	311.0	212.2	37.2	14.5
Off-Enl	467	1228	321.4	213.8	35.8	15.7

TABLE V. STATISTICS OF INDIVIDUALS WITH A GAP IN THEIR SHOOTING HISTORY

DATA SET	NUMBER SUBJECTS PISTOL	NUMBER SUBJECTS RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE
Off-Div	68	72	324.4	221.2	32.2	19.5
Off-Wing	101	75	337.2	219.2	30.4	25.1
Enl-Div	63	173	306.4	213.6	38.9	15.1
Enl-Wing	87	295	315.3	212.5	35.7	15.4
Officer	168	148	331.9	221.0	31.8	21.7
Enlisted	151	468	311.3	213.1	37.6	15.3
Off-Enl	319	616	322.1	214.8	36.2	17.2

B. ANALYSIS OF VARIANCE (ANOVA)

An analysis of variance was performed on the Officer-Division, Officer-Wing, Enlisted-Division and Enlisted-Wing population group to test the hypothesis that there are no treatment effects

at a level of significance of .1. The analyses were performed by taking a random sample from each population group. The sample consisted of the first fifteen individuals who did not have a gap in their shooting history. There were three population groups in which it was not possible to obtain fifteen individual sets of scores due to the prevalence of gaps in the individual's shooting history. In these cases, the sample size utilized in the analysis was reduced. Table VI provides a tabulated summary of ANOVA analyses for both the pistol and rifle weapon types. Table VI displays the F-ratio generated by the Randomized Block Design presented by Hicks [Ref. 8], a "YES" if the individual or if time was significant or a "NO" if insignificant and the sample size used in the ANOVA. The below ANOVA summary is a sample of ANOVA tables that are summarized in Table VI.

ANOVA (Enlisted-Division)

SOURCE	DF	SS	MS	F-RATIO
Individual	14	65854	4705	6.76
Time (YRS)	5	5017	1003	1.44
Error	70	48715	696	
Total	89	119586		

The results of the ANOVA's indicate that there is an individual effect for both the pistol and rifle weapon types, whereas there are no time effects for the pistol and rifle weapon types except for the Officer-Division and Enlisted-Division population groups with the pistol.

TABLE VI. SUMMARY OF ANOVA RESULTS

A. PISTOL

DATA SET	SAMPLE SIZE K	Y	F-RATIO IND.	TIME	D.F.(V_1) IND.	TIME	D.F.(V_2) IND.	TIME	F(V_1,V_2) IND.	TIME	SIGNIFICANT? IND.	TIME
Off-Div	15	6	7.05	2.04	14	5	70	70	1.59	1.93	YES	YES
Off-Wing	12	6	10.81	1.80	11	5	54	54	1.64	1.83	YES	NO
Enl-Div	10	6	4.6	2.13	9	5	42	42	1.79	2.00	YES	YES
Enl-Wing	15	6	6.76	1.44	14	5	70	70	1.59	1.93	YES	NO

B. RIFLE

DATA SET	SAMPLE SIZE K	Y	F-RATIO IND.	TIME	D.F.(V_1) IND.	TIME	D.F.(V_2) IND.	TIME	F(V_1,V_2) IND.	TIME	SIGNIFICANT? IND.	TIME
Off-Div	12	6	4.59	1.56	11	5	54	54	1.64	1.83	YES	NO
Off-Wing	13	6	1.96	1.84	9	5	43	43	1.78	1.99	YES	NO
Enl-Div	15	6	4.35	1.76	14	5	70	70	1.59	1.93	YES	NO
Enl-Wing	15	6	5.32	.18	14	5	70	70	1.59	1.93	YES	NO

K=NUMBER OF INDIVIDUALS

Y=NUMBER OF YEARS

C. CONTINGENCY TABLE ANALYSES

Contingency table analyses were performed for both the pistol and rifle weapon types for the following population groups in terms of gap size with emphasis on the Officer Combined and Enlisted Combined groups:

Officer-Division

Officer-Wing

Enlisted-Division

Enlisted-Wing

Officer Combined

Enlisted Combined

Officer-Enlisted Combined

In addition to the above population groups, the analyses were also performed on the below data sets which are combinations of the above population groups:

Set A: Officer-Division, Officer-Wing, Enlisted-Division, Enlisted-Wing

Set B: Officer Combined, Enlisted Combined

The analysis tested the hypothesis that there is no statistical difference in ΔSCORE associated with gap size and that there is no statistical difference in ΔSCORE associated with population groups. The hypotheses were tested at a level of significance of .1 utilizing the Chi-square test described in Siegel [Ref. 9]. The following two tables represent examples of the contingency analyses used to test both hypotheses.

DATA SET: ENLISTED-DIVISION (PISTOL)

ΔSCORE

GAP	-25+ to -21	-20 to -1	0 to 20	21 to 25+
0	4	5	6	7
1	13	9	13	12
2	2	5	6	8
3	2	5	3	5
4+	3	1	1	4

GAP SIZE: ZERO

ΔSCORE

DATA SET	-25+ to -21	-20 to -6	-5 to -15	6 to 15	16 to 25	25+
Off-Div	5	7	5	8	5	12
Off-Wing	2	4	7	3	3	11
Enl-Div	4	5	1	4	1	7
Enl-Wing	8	3	5	6	8	23

Table VII provides a summary of the contingency table analysis results for the hypothesis of no differences in ΔSCOREs associated to gap size. The hypothesis is not rejected for any of the data sets for the pistol weapon type and in the case of the rifle, is rejected for all data sets except for Officer-Division and Officer data sets.

TABLE VII. SUMMARY OF CONTINGENCY TABLE ANALYSIS FOR TESTING

H_o: No Difference in ΔSCOREs Due to Gap Size

A. PISTOL

DATA SET	X^2 STATISTIC	DF	P-VALUE	ACCEPT OR REJECT H_o
Off-Div	14.113	16	.590	ACCEPT
Off-Wing	9.158	12	.689	ACCEPT
Enl-Div	7.447	12	.827	ACCEPT
Enl-Wing	12.737	12	.388	ACCEPT
Officer	20.640	28	.825	ACCEPT
Enlisted	20.700	24	.638	ACCEPT
Off-Enl	32.200	40	.800	ACCEPT

B. RIFLE

DATA SET	X^2 STATISTIC	DF	P-VALUE	ACCEPT OR REJECT H_o
Off-Div	7.971	12	.787	ACCEPT
Off-Wing	14.960	8	.060	REJECT
Enl-Div	41.170	20	.005	REJECT
Enl-Wing	61.250	44	.025	REJECT
Officer	24.610	28	.628	ACCEPT
Enlisted	98.930	44	.0001	REJECT
Off-Enl	95.78	44	.0001	REJECT

Table VIII is a tabulated summary of the pistol contingency table analysis results for the hypothesis testing for no statistical differences in ΔSCOREs associated to the population groups. For the pistol, the hypothesis is not rejected

for all data sets except for data set B with a four plus year gap in shooting history. In the case of the rifle results tabulated in Table IX, the hypothesis is not rejected for data set A except for the zero gap and the four plus year gap in shooting history, and is accepted for data set B except for the zero gap case.

The prevalence of rejections in Table IX may possibly be due to mean age differences between the Officer Combined and the Enlisted Combined population groups, or to intelligence levels associated to the educational backgrounds of the two population groups. Since age and intelligence test scores are not available in the data, it is not possible to validate the effects of these influences on the populations under study.

The environmental and physiological aspects of firing a rifle over distances of 200 to 500 yards as compared to the pistol which is fired at a maximum range of 25 yards can impact on rifle ΔSCOREs. The introduction of this study introduced the reader to the physiological aspects of proficient marksmanship shooting which impacts upon a shooter's qualification score. As previously noted, the visual system is required to attain proper sight alignment and sight picture in the process of aiming the weapon. In terms of wind and visibility, the environmental influences of weather has a greater effect on shooting accuracy over longer distances then shorter distances. This problem can affect the rifle

TABLE VIII. SUMMARY OF CONTINGENCY TABLE ANALYSIS FOR TESTING H_o: No Difference in ΔSCORE Due to Population Groups

DATA SET*	GAP (YR)	X^2 STATISTIC	PISTOL DF	P-VALUE	ACCEPT OR REJECT
A	0	15.03	15	.451	ACCEPT
A	1	22.16	21	.390	ACCEPT
A	2	11.16	12	.515	ACCEPT
A	3	.93	3	.818	ACCEPT
A	4+	7.41	6	.285	ACCEPT
B	0	5.73	10	.830	ACCEPT
B	1	14.31	11	.216	ACCEPT
B	2	5.03	6	.541	ACCEPT
B	3	3.47	3	.324	ACCEPT
B	4+	9.82	4	.044	REJECT

* Data Set A: Officer-Division, Officer-Wing, Enlisted-Division, Enlisted-Wing

Data Set B: Officer Combined, Enlisted Combined

TABLE IX. SUMMARY OF CONTINGENCY TABLE ANALYSIS FOR TESTING H_o: No Difference in ΔSCORE Due to Population Groups

RIFLE

DATA SET*	GAP (YR)	X^2 STATISTIC	DF	P-VALUE	ACCEPT OR REJECT
A	0	39.04	24	.027	REJECT
A	1	32.77	27	.205	ACCEPT
A	2	9.86	12	.628	ACCEPT
A	3	6.07	9	.733	ACCEPT
A	4+	30.22	12	.003	REJECT
B	0	17.24	9	.044	REJECT
B	1	19.27	11	.056	REJECT
B	2	4.60	9	.868	ACCEPT
B	3	8.59	6	.198	ACCEPT
B	4+	12.19	8	.143	ACCEPT

* Data Set A: Officer-Division, Officer-Wing, Enlisted-Division, Enlisted-Wing

Data Set B: Officer Combined, Enlisted Combined

ΔSCOREs since the environmental conditions may be different from one qualification period to another which may result in an increase or decrease in ΔSCORE.

D. REGRESSION ANALYSIS

Regression analyses were performed on the Officer Combined, Enlisted Combined and Officer-Enlisted Combined data sets for both pistol and rifle weapon types. The analyses involved regressing Time (in years) with ΔSCOREs to test the hypothesis that ΔSCOREs over time have zero slope, which indicates no change in marksmanship performance. The hypothesis is generated by Richards' [Ref. 10] APL program, determining the p-value from the F tables and comparing the p-value to the level of significance (α) of .1. If $p<\alpha$, reject the hypothesis, otherwise, do not reject the hypothesis. The following is an example of the computer output generated by the program for the Officer Combined data set and pistol weapon type with a one year gap in shooting history.

ANOVA

SOURCE	DF	SUM SQUARES	MEAN SQUARES	F-RATIO
REGRESSION	1	6.6784E2	6.6784E2	7.1568E-1
RESIDUAL	48	4.4791E4	9.3314E2	
TOTAL	49	4.5459E4		

R SQUARE: 0.01469

STD ERROR: 30.54739

COEFFICIENTS	T STATISTICS
17.5312	1.8026
-1.35	-0.846

From the F table provided by Hicks [Ref. 8] with F(1,48) equal to .71568 provided a p-value of .790. Since this p-value is greater than .1, the hypothesis that the slope is zero is not rejected.

The results of the regression analysis and hypothesis tests are tabulated in Table X which displays the mean and standard deviations for Time (in years) and ΔSCOREs across a gap in shooting history. The table also displays the slope and Y-intercept generated by the APL regression program, the sample size used to generate the statistics and whether the hypothesis was accepted or rejected. The random samples used in the analyses represents the first 50 ΔSCOREs attained for each gap size within the population group under study. In those situations in which 50 ΔSCOREs were not available, all ΔSCOREs for that gap size within the population group under study were utilized.

The results of the table indicate that the hypothesis of zero slope was not rejected for all gap sizes for the Officer Combined data set for both the pistol and rifle weapon types. In the case of the Enlisted Combined data set, the hypothesis of zero slope was rejected only for the pistol weapon type with a three year gap in shooting history and was not rejected in any other gap sizes.

E. CONDITIONAL PROBABILITY STATISTICS

For the purpose of providing the reader with additional information concerning the effects of a gap in an individual's shooting history, the mean scores, standard deviations, and frequency of occurances were determined and tabulated in Appendix E for each of the data sets listed in paragraph A with the following conditions:

A. Expert after gap given shot sharpshooter or better before the gap.

B. Expert after gap given shot expert before the gap.

C. Sharpshooter after gap given shot sharpshooter or better before the gap.

D. Sharpshooter after gap given shot expert before the gap.

E. Expert after gap given shot expert two times in row before the gap.

F. Expert after gap given shot expert three times in row before the gap.

G. Expert after gap given shot expert two times in a row.

H. Expert after gap given shot expert three times in a row.

TABLE X. SUMMARY OF REGRESSION ANALYSIS

A. PISTOL

OFFICER

GAP (YRS)	MEAN YEARS	MEAN ΔSCORE	STD. DEV. YEARS	STD. DEV. ΔSCORE	Y-INTERCEPT	SLOPE	SAMPLE SIZE	ACCEPT OR REJECT	P VALUE
0	4.92	13.98	1.98	37.2	27.6	-2.78	50	ACCEPT	.307
1	5.46	10.16	2.73	30.45	17.53	-1.35	50	ACCEPT	.790
2	6.04	13.58	2.73	26.06	15.41	- .30	45	ACCEPT	.835
3	6.07	4.92	1.75	30.30	-18.40	+3.85	13	ACCEPT	.465
4+	7.95	-1.15	2.00	31.60	-17.90	+2.10	40	ACCEPT	.412

ENLISTED

GAP (YRS)	MEAN YEARS	MEAN ΔSCORE	STD. DEV. YEARS	STD. DEV. ΔSCORE	Y-INTERCEPT	SLOPE	SAMPLE SIZE	ACCEPT OR REJECT	P VALUE
0	4.86	14.52	2.04	36.68	10.36	+ .86	50	ACCEPT	.743
1	5.46	1.02	3.05	40.02	10.48	-1.70	50	ACCEPT	.361
2	6.52	4.05	2.80	31.04	11.13	-1.09	42	ACCEPT	.538
3	6.97	12.13	2.19	41.40	54.00	-6.01	30	REJECT	.087
4+	8.35	17.50	2.02	37.07	30.32	-1.53	26	ACCEPT	.685

TABLE X. CONTINUED

B. RIFLE

OFFICER

GAP (YRS)	MEAN YEARS	MEAN ΔSCORE	STD. DEV. YEARS	STD. DEV. ΔSCORE	Y-INTERCEPT	SLOPE	SAMPLE SIZE	ACCEPT OR REJECT	P VALUE
0	4.26	5.76	2.65	17.50	5.16	+ .14	50	ACCEPT	.929
1	4.45	8.43	2.11	13.26	12.77	- .99	50	ACCEPT	.277
2	5.38	3.59	1.86	12.81	5.17	- .29	42	ACCEPT	.789
3	6.52	-3.30	1.70	17.24	6.66	-1.52	23	ACCEPT	.492
4+	8.06	2.06	1.74	14.20	-2.60	+ .57	34	ACCEPT	.690

ENLISTED

GAP (YRS)	MEAN YEARS	MEAN ΔSCORE	STD. DEV. YEARS	STD. DEV. ΔSCORE	Y-INTERCEPT	SLOPE	SAMPLE SIZE	ACCEPT OR REJECT	P VALUE
0	4.00	13.74	1.41	17.18	11.98	+ .44	50	ACCEPT	.804
1	5.00	1.48	2.88	18.93	-2.33	+ .74	50	ACCEPT	.434
2	6.14	1.86	2.80	20.38	3.52	- .27	49	ACCEPT	.800
3	6.9	0.26	2.26	17.67	2.75	- .35	50	ACCEPT	.749
4+	9.26	9.06	2.76	21.82	7.91	+ .12	49	ACCEPT	.915

IV. CONCLUSIONS

A. POPULATION GROUPS

For the Officer population group, there is no statistical degradation in small arms marksmanship shooting performance resulting from a one, two, three, or four plus year gap in shooting history, for either the pistol or rifle weapon types. In the case of the Enlisted population group, there is a split between the pistol and rifle weapon types results. In the case of the pistol weapon type, there is no statistical degradation in shooting performance for a one or two year gap in shooting history; however, there is statistical evidence that a three or more year gap does have a significant effect upon shooting performance. In the case of the rifle weapon type, there is no statistical degradation of marksmanship performance across the one, two, three, or four plus year gap in shooting history.

B. SIGNIFICANCE OF CONCLUSIONS

The conclusions may provide a basis for future marksmanship training decisions which may result in a significant cost savings.

V. RECOMMENDATIONS FOR FURTHER STUDY

In addition to the analyses conducted for this study, it is recommended tht the following areas be studied:

1. Analyze the data by Military Occupational Specialty (MOS) to determine if there are any performance effects within the MOS groupings.

2. Analyze the data to determine the feasibility of constructing an analytical model which would predict marksmanship performance after the individual has achieved a specific level of performance.

3. Perform analyses with ΔSCORE for zero gap based on spans of years consistant with those involved in the gap data.

4. Conduct a cost/benefit analysis of proficiency shooting, using operational measure of the benefits of small arms accuracy.

APPENDIX A

DESCRIPTION OF COURSES FOR INDIVIDUAL MARKSMANSHIP M16A1 RIFLE, M1911A1 PISTOL AND .38 CALIBER REVOLVER

A. RIFLE COURSES

1. Course Known Distance (KD)

STAGE	RANGE (YARDS)	TIME (MINS)	ROUNDS	TARGET	POSITION
1	200	5	5	"A"	Sitting
2	200	5	5	"A"	Kneeling
3	200	5	5	"A"	Standing
4	200	1	10	"D"	Standing to Sitting
5	300	5	5	"A"	Sitting
6	300	1	10	"A"	Standing to Prone
7	500	10	10	"B"	Prone

a. For stages 4 and 6, two magazines are loaded with five rounds each. The shooter is required to change magazines and reload his rifle from the cartridge belt.

b. The dimensions of the "A", "D" and "B" modified targets are as depicted in Figures (5) to (7). A hit in the black is given the maximum score value of "5". Hits outside the rings are "2".

c. Each shot is marked and disked.

d. Classification scores:

	EXPERT	SHARPSHOOTER	MARKSMAN
Score	220	210	190

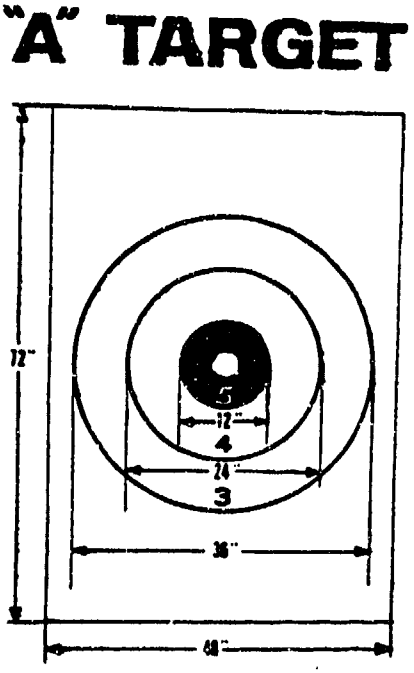


Figure (5) Standard "A" Target

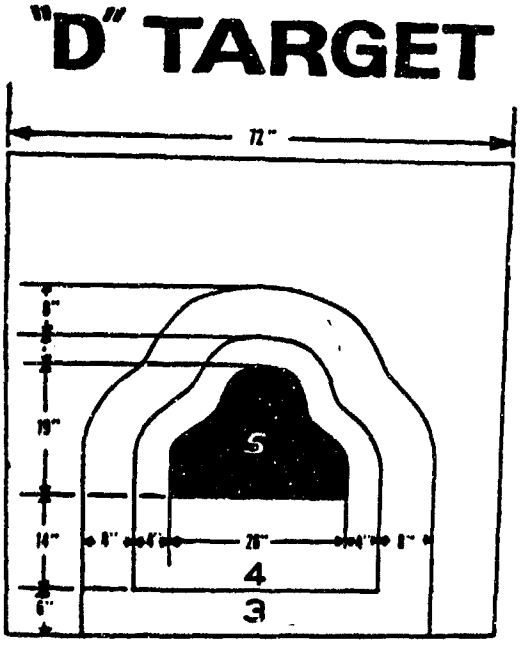


Figure (6) Standard "D" Target

MODIFIED
"B" TARGET

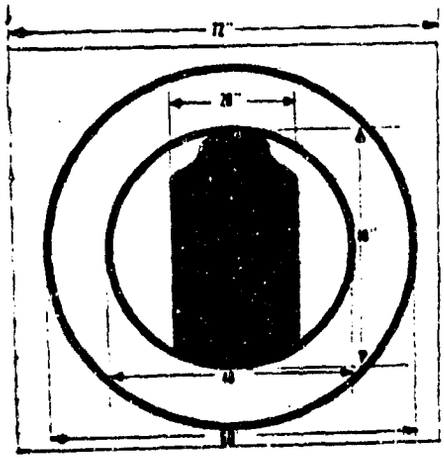


Figure (7) Standard "B Modified Target

2. Course "B"

STAGE	RANGE (YARDS)	TIME (MINS)	ROUNDS	TARGET	POSITION
1	200	10	10	"A"	Prone
2	200	5	5	"A"	Sitting
3	200	5	5	"A"	Kneeling
4	200	10	10	"A"	Standing
5	200	1	10	"D"	Standing to Prone
6	200	1	10	"D"	Standing to Sitting

a. For stages 5 and 6, two magazines with five rounds each are used. The shooter is required to change magazines and reload his rifle from the cartridge belt.

b. Classification Scores:

	EXPERT	SHARPSHOOTER	MARKSMAN
Score	225	215	190

3. Course "B" Modified

STAGE	RANGE (YARDS)	TIME (MINS)	ROUNDS	TARGET	POSITION
1	200	5	5	"A"	Sitting
2	200	5	5	"A"	Kneeling
3	200	10	10	"A"	Standing
4	200	1	10	"D"	Standing to Sitting
5	300	10	10	"A"	Prone
6	300	1	10	"D"	Standing to Prone

a. For stages 4 and 6, two magazines with five rounds each are used. The shooter is required to change magazines and reload his rifle from the cartridge belt.

b. Classification Scores:

	EXPERT	SHARPSHOOTER	MARKSMAN
Score	220	210	190

B. PISTOL AND REVOLVER COURSES

1. Course "A"

RANGE (YARDS)	TIME	ROUNDS	TARGET	TYPE OF FIRE
25	10 min	10	E-SA	Slow
15	15 sec per string	10 (2 strings)	E-SA	Rapid
25	20 sec per string	10 (2 strings)	E-SA	Timed
25	3 sec per shot	10	E-SA	Quick

a. Target E-SA, dipicted in Figure (8), consists of target "D" silhouette with a Standard American 25 yard target over it, the "five ring" of the target being tangent to the shoulder of the silhouette and overlapping sides trimmed off or folded and pasted to the back of the target.

b. All hits on either the SA target or the "E" target outside of the "five ring" is scored as four in slow, timed fire and rapid fire. For the Quick Fire string, any shot cutting the edge of the "E" target is recorded as a hit.

c. Classification Scores:

	EXPERT	SHARPSHOOTER	MARKSMAN
Score	330	290	230

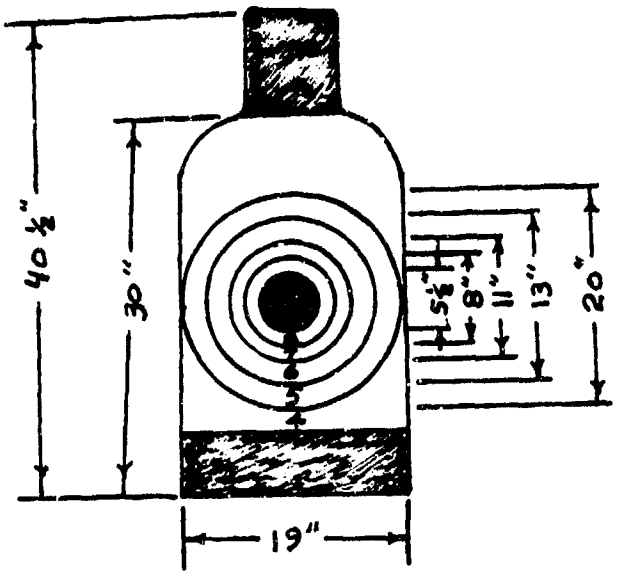


FIGURE (8) E-SA Pistol Target

APPENDIX B

RECORD KEEPING REQUIREMENTS AND PROCEDURES

A. SCORECARDS AND SCORING

The following is a list of procedures which are utilized in the recording of marksmanship scores for record as required by reference (5).

1. Scorecards are kept at each target in the pits. The cards will bear the date, the number of the target, and the number of the relay.

2. Entries on all scorecards are made in ink or indelible pencil. When necessary corrections are made, each correction will be initialed by the block officer supervising the scoring in the pits.

3. The score at each target is kept by a scorer. As soon as a score is completed, the scorecard will be signed by the scorer and collected and verified by the block officer. Upon completion of the day's firing, scorecards will be turned over to the range officer.

4. The range officer will prepare an accurate roster of the firing detail to include the firer's identifying information, his target number, and his relay number.

5. Upon completion of record firing, the range officer will collect all scorecards, place the firer's identifying information on the scorecard, and forward all scorecards to

the rifle range commanding officer, who will cause the scores to be transmitted to the various activities concerned.

6. After the record score has been verified, the score-cards will be kept available for inspection among the rifle range records for 1 year and then destroyed.

7. Upon completion of record firing, the date, range, course, weapon, score and qualification classification attained will be recorded in the OQR/SRB of each officer or enlisted Marine concerned on NAVMC 118 form as depicted in APPENDIX D.

B. GENERAL RULES

The following are rules which provide scoring procedures and procedures to be utilized in unusual situations:

1. Sighting shots are prohibited during record firing.

2. Each shot fired on the wrong target will be scored as a miss.

3. Ricochets will be counted as misses.

4. When a target has more than the authorized number of hits, the following will govern:

(a) Slow Fire. If two or more shots strike the target at approximately the same time and are not of the same value, the shot with the highest value is recorded.

(b) Rapid Fire. If a target has more than the prescribed number of hits, all of the same value, the targets will be scored with the value of the number of shots actually fired by the individual. If the target has more than the prescribed

number of hits, not all of the same value, the target will not be marked and the individual will be required to refire the entire string.

5. If a target is withdrawn just as a shot is fired in slow fire or before the time limit has expired in rapid fire, the shooter will be allowed to refire the shot in slow fire or the entire string in rapid fire, as appropriate. It must be substantiated, however, that the target was withdrawn prematurely.

6. If a slow-fire string is interrupted or delayed through no fault of the individual, he is given extra time or allowed to finish the string at the first opportunity. No other stage will commence until the previous stage has been completed.

7. If a weapon stoppage occurs during rapid fire, the weapon will be inspected by the officer in charge of the firing or a qualified armorer, and the following procedures will be followed:

(a) If it is determined that the stoppage was caused by a mechanical failure of the weapon or by faulty ammunition, the scores will be disregarded and the individual will be permitted to refire the entire string.

(b) If it is determined that the stoppage was caused through the fault or neglect of the individual, all unfired rounds will be scored as misses.

(c) In no case where a stoppage occurs will the target be marked until the nature of the stoppage has been determined.

C. TARGET SYSTEM

The following describes the type of targets utilized for the various strings of fire:

1. The standard "A" target, bulls-eye, paper, 200 and 300 yard targets are used for all slow fire stages at 200 and 300 yards, Figure (1).

2. The standard "D" target, silhouette, paper, prone images target will be used for sustained fire stages, Figure (2).

3. The 500 yard stage is fired on the "B" Modified target. This target consists of the "E" target, silhouette, paper, kneeling, image superimposed upon a bulls-eye paper target, Figure (3).

4. The E-SA target utilized for pistol requalification consists of target "E" silhouette with a Standard American 25 yard target over it, the "five ring" of the target being tangent to the shoulder of the silhouette and overlapping sides trimmed off or folded and pasted to the back of the target, Figures (4) and (5).

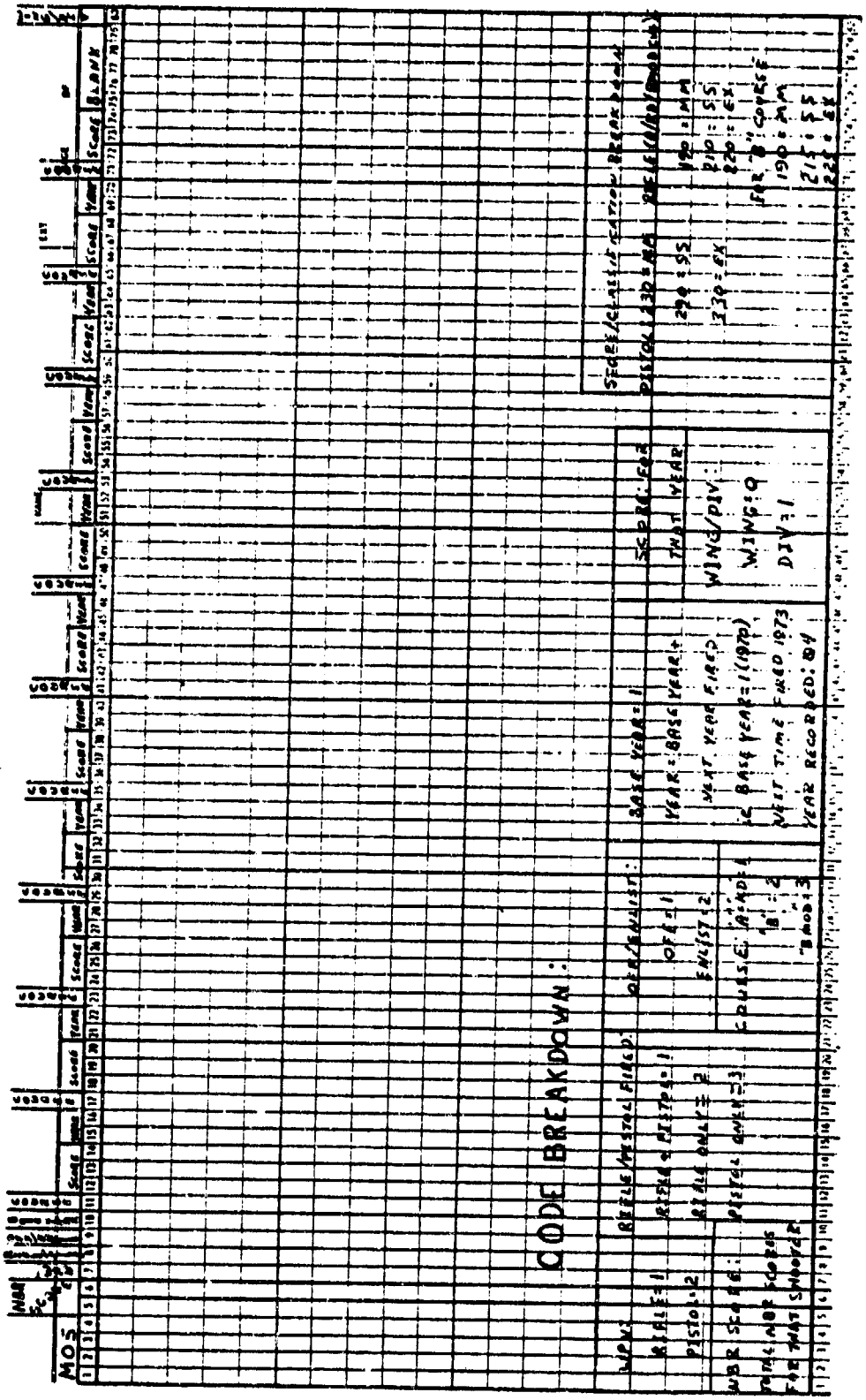
D. RIFLE COURSE SCORING SYSTEM

A value of five points will be awarded for any shot within or touching any portion of the bulls-eye on the "A" target or the silhouette of the "D" or "B" targets. Any bullet

striking the target outside the silouette or bulls-eye shall be scored with the point value idicated by the shot hole, being a four, three, or two. Any shot striking the target outside the "three ring" is scored as a value of two. Any shot hole outside the target paper area is scored as a miss.

APPENDIX C

DATA CODING SHEET



APPENDIX D

NAVMC 118

WEAPONS FIRING RECORD, COMPETITIVE MARKSMANSHIP (1979)

WEAPONS FIRING RECORD

DATE	COURSE	WEAPON	SCORE, FINAL QUALIFICATION	SIGNATURE OF CERTIFYING OFFICER
760401	A	.45 Pistol	333 EX	
760605	KD	M-16	221 EX	
770722	KD	M-16	227 EX	
780928	KD	M-16	210 SS	
781117	A	.45 Pistol	368 EX	
790525	A	.38 Cal	345 EX	
790830	B MOD	M-16	230 EX	
800115	KD	M-16	195 MM	

EXPERT REQUALIFICATION BAR RECORD

WEAPON	AWARD	YEARS	WEAPON	AWARD	YEAR
M-16	1st	1977	Pistol	1st	1979
M-16	2nd	1979			

COMPETITIVE MARKSMANSHIP

MATCH PARTICIPATED IN	DATES	SCORE, FINAL/POSSIBLE	PLACING (TEAM COMPETITION)	BADGES AWARDED

ADDITIONAL MARKSMANSHIP INFORMATION

ENDORSED PLATE IMPRESSION

NAME, M. Y.	456 78 9012
NAME (Last) (First) (Middle)	SERVICE NO.

NAVMC 118 (6) (REV. 8-67) (Previous editions are obsolete and will not be used)

APPENDIX E

STATISTICS ON CONDITIONAL PROBABILITY ANALYSIS

A. CONDITION: EXPERT GIVEN SHOT SHARPSHOOTER OR BETTER BEFORE THE GAP

DATA SET	NBR SHOOTERS W/THIS COND.		% SHOOTERS W/THIS COND.		MEAN SCORE		STD. DEV.		NBR SHOOTERS SS+ BEFORE GAP	
	PISTOL	RIFLE	PISTOL	RIFLE	PISTOL	RIFLE	PISTOL	RIFLE	PISTOL	RIFLE
Off-Div	38	26	55.1	35.6	336.5	230.3	26.5	24.4	56	41
Off-Wing	71	11	69.6	14.7	345.6	234.7	21.0	40.4	89	22
Enl-Div	16	20	25.0	11.6	334.5	223.9	28.6	12.5	40	69
Enl-Wing	31	25	35.6	8.5	335.8	221.2	19.1	12.2	57	61
Officer	108	37	63.2	24.8	342.4	231.5	23.5	29.5	145	63
Enlisted	47	45	30.9	9.6	335.4	222.6	23.0	12.4	97	130
Off-Enl	156	82	48.2	13.3	340.2	226.2	23.5	21.4	243	193

B. CONDITION: EXPERT GIVEN SHOT EXPERT BEFORE THE GAP

DATA SET	NBR SHOOTERS W/THIS COND. PISTOL	NBR SHOOTERS W/THIS COND. RIFLE	% SHOOTERS W/THIS COND. PISTOL	% SHOOTERS W/THIS COND. RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE	NBR SHOOTERS EXP BEFORE GAP PISTOL	NBR SHOOTERS EXP BEFORE GAP RIFLE
Off-Div	24	15	34.8	20.5	343.1	233.3	24.2	30.9	29	25
Off-Wing	51	6	50.0	8.0	348.8	240.9	20.3	49.2	57	11
Enl-Div	9	12	14.1	7.0	341.8	226.2	23.6	11.5	14	26
Enl-Wing	22	13	25.3	4.4	338.8	223.7	17.1	11.7	33	30
Officer	75	21	43.9	14.1	347.0	235.5	21.7	37.0	87	36
Enlisted	31	25	20.4	5.3	339.8	225.1	19.5	11.6	47	56
Off-Enl	106	46	32.7	7.4	344.8	229.6	21.3	26.2	134	92

C. CONDITION: SHARPSHOOTER GIVEN SHOT SHARPSHOOTER OR BETTER BEFORE THE GAP

DATA SET	NBR SHOOTERS W/THIS COND.		% SHOOTERS W/THIS COND.		MEAN SCORE		STD. DEV.		NBR SHOOTERS SS+ BEFORE GAP	
	PISTOL	RIFLE	PISTOL	RIFLE	PISTOL	RIFLE	PISTOL	RIFLE	PISTOL	RIFLE
Off-Div	11	10	15.9	13.7	321.3	221.6	26.2	10.9	56	41
Off-Wing	14	5	13.7	6.7	322.2	223.0	24.1	6.0	89	22
Enl-Div	17	23	26.6	13.3	312.6	219.7	25.6	14.1	40	69
Enl-Wing	20	12	23.0	4.1	319.9	218.5	20.3	11.6	57	61
Officer	25	15	14.6	10.1	321.9	222.0	24.9	9.7	145	63
Enlisted	37	35	24.3	7.5	316.0	219.3	24.3	13.3	97	130
Off-Enl	62	50	19.1	8.1	318.2	220.0	24.6	12.6	243	193

D. CONDITION: SHARPSHOOTER GIVEN SHOT EXPERT BEFORE THE GAP

DATA SET	NBR SHOOTERS W/THIS COND. PISTOL	NBR SHOOTERS W/THIS COND. RIFLE	% SHOOTERS W/THIS COND. PISTOL	% SHOOTERS W/THIS COND. RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE	NBR SHOOTERS EXP BEFORE GAP PISTOL	NBR SHOOTERS EXP BEFORE GAP RIFLE
Off-Div	4	6	5.8	8.2	331.7	223.6	19.8	9.7	29	25
Off-Wing	3	3	2.9	4.0	334.7	224.5	15.8	5.4	57	11
Enl-Div	4	7	6.3	4.1	325.0	222.4	26.5	18.3	14	26
Enl-Wing	9	7	10.3	2.4	330.2	220.0	19.5	13.9	33	30
Officer	7	9	4.1	6.0	333.0	223.8	18.0	8.6	87	36
Enlisted	13	14	8.6	3.0	328.2	221.2	22.3	16.1	47	56
Off-Enl	20	23	6.2	3.8	330.0	222.1	20.9	14.0	134	92

E. CONDITION: EXPERT GIVEN SHOT EXPERT TWO TIMES IN ROW BEFORE THE GAP

DATA SET	NBR SHOOTERS W/THIS COND. PISTOL	NBR SHOOTERS W/THIS COND. RIFLE	% SHOOTERS W/THIS COND. PISTOL	% SHOOTERS W/THIS COND. RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE	NBR SHOOTERS EXP 2X BEFORE GAP PISTOL	NBR SHOOTERS EXP 2X BEFORE GAP RIFLE
Off-Div	17	9	24.6	12.3	345.7	227.1	22.3	8.1	20	11
Off-Wing	39	1	38.2	1.3	347.8	224.7	18.4	11.0	42	2
Enl-Div	6	7	9.4	4.0	333.8	228.9	22.1	9.9	9	12
Enl-Wing	12	6	13.8	2.0	340.7	228.6	19.8	6.2	14	10
Officer	56	10	32.7	6.7	347.2	226.8	19.6	8.4	63	13
Enlisted	18	13	11.8	2.8	338.4	228.8	20.8	8.7	23	22
Off-Enl	74	23	22.8	3.7	345.1	228.0	20.2	8.6	86	35

F. CONDITION: EXPERT GIVEN SHOT EXPERT THREE TIMES IN ROW BEFORE THE GAP

DATA SET	NBR SHOOTERS W/THIS COND. PISTOL	NBR SHOOTERS W/THIS COND. RIFLE	% SHOOTERS W/THIS COND. PISTOL	% SHOOTERS W/THIS COND. RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE	NBR SHOOTERS EXP 3X BEFORE GAP PISTOL	NBR SHOOTERS EXP 3X BEFORE GAP RIFLE
Off-Div	10	5	14.5	6.8	349.3	226.5	14.0	9.5	12	6
Off-Wing	26	1	25.5	1.3	349.0	224.7	15.6	11.0	29	1
Enl-Div	3	3	4.7	1.7	331.5	232.9	29.3	7.4	5	5
Enl-Wing	8	2	9.2	.7	343.4	229.6	20.6	4.3	11	3
Officer	36	6	21.1	4.0	349.1	226.2	15.1	9.6	42	7
Enlisted	11	5	7.2	1.1	340.1	232.0	23.7	6.8	16	8
Off-Enl	47	11	14.5	1.8	347.0	228.7	17.8	8.9	58	15

G. CONDITION: EXPERT GIVEN SHOT EXPERT TWO TIMES IN A ROW

DATA SET	NBR SHOOTERS W/THIS COND. PISTOL	NBR SHOOTERS W/THIS COND. RIFLE	% SHOOTERS W/THIS COND. PISTOL	% SHOOTERS W/THIS COND. RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE
Off-Div	47	58	43.1	49.6	341.1	227.9	25.6	17.6
Off-Wing	81	27	61.4	26.7	347.1	227.3	19.7	25.9
Enl-Div	22	84	25.9	16.9	334.3	223.6	26.6	11.2
Enl-Wing	51	82	35.5	16.0	337.5	221.9	23.0	11.1
Officer	128	85	53.1	39.0	344.9	227.7	22.2	20.6
Enlisted	73	166	31.9	16.4	336.2	222.6	24.9	11.5
Off-Enl	201	251	42.8	20.4	341.6	224.5	23.8	15.0

H. CONDITION: EXPERT GIVEN SHOT EXPERT THREE TIMES IN A ROW

DATA SET	NBR SHOOTERS W/THIS COND. PISTOL	NBR SHOOTERS W/THIS COND. RIFLE	% SHOOTERS W/THIS COND. PISTOL	% SHOOTERS W/THIS COND. RIFLE	MEAN SCORE PISTOL	MEAN SCORE RIFLE	STD. DEV. PISTOL	STD. DEV. RIFLE
Off-Div	31	40	28.4	34.2	347.4	229.5	19.6	19.4
Off-Wing	59	11	44.7	10.9	348.4	233.7	18.6	35.9
Enl-Div	14	37	16.5	7.4	337.0	225.2	27.2	11.4
Enl-Wing	26	27	18.1	5.3	340.7	225.7	22.6	8.4
Officer	90	51	37.3	23.4	348.1	230.5	18.9	24.0
Off-Enl	130	115	27.7	9.4	344.6	227.4	22.4	17.3

The "% SHOOTERS W/THIS COND." column of the Appendix was calculated by dividing the "NBR SHOOTERS W/THIS COND." column by the total number of individuals that had a gap within the indicated data set except for parts G and H. The "% SHOOTERS W/THIS COND." column for parts G and H was calculated by dividing the "NBR SHOOTERS W/THIS COND." column by the total number of shooter involved with the population set as provided in Table IV.

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